A PORTABLE CASE FOR WATER ANALYSIS IN ECOLOGICAL FIELD WORK

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In ecological field work including the measurement of various physical conditions of the environment, the convenient transportation of equipment is always an important consideration, particularly when the analysis of natural waters is involved. The portable case described here was designed to carry the glassware and solutions used in the Winkler method for dissolved oxygen, a modified Seyler method for carbonates and free carbon dioxide and the colorimetric method for determination of pH. It was planned also to make possible analysis of water samples in the field permitting immediate calculation of results. The design is based upon the experience of carrying on such work with classes in elementary ecology and with graduate students engaged in the study of pond, stream and marine littoral communities. (Dreyer, 1940; Dreyer and Castle, 1941; King, Jos. E., 1943; King, Willis, 1934, and Ward, 1940.) Acknowledgment is made herewith of the accumulated suggestions of numerous students and co-workers. While not claiming complete originality of design the author presents this description to promote the more widespread use of such field equipment in ecological work of both the classroom and research level.

CONSTRUCTION AND INTERNAL ARRANGEMENT

The case itself is a wooden box, made of one-half inch clear white pine, measuring 33 x 18 x 9 inches. It consists of two parts, the body of the box (6 inches deep) and the lid (3 inches deep), which are hinged at one end with three two-inch iron hinges and held securely in place when closed by two three-inch barrel bolts and a small clasp with a hook fastener at the other end. All the joints are made with flat-head screws set flush with the surface. The 33 x 18 inch sides are reinforced with 3 x 16 inch strips set crosswise four and one-half inches from each end.

Heavy one-inch leather straps, screwed to the reinforcing strips on each side and buckled when the case is closed to form about 18-inch loops, serve as handles. The case is conveniently carried by two people with the 18-inch dimension upright (as a large suitcase) either by using the strap loops directly as handles or by thrusting a strong pole from a seine or heavy dip net through the two loops. The dimensions of the case are such that it will stand upright on the floor behind the front seat or in the baggage compartment of any automobile of recent model. When in use the case is placed in a slightly elevated position and the lid opened to an angle of about 135 degrees. Thus, the operator may squat or sit comfortably in front of the open case with all equipment within easy reach.

The inside of the case (figure 1) is fitted with sample bottles, solutions and other glassware. In the six-inch wide compartment on the left is a two-liter dark glass bottle containing $N/40$ sodium thiosulphate.[1] It is covered with black cloth and provided with a calcium chloride tube and a glass delivery tube with screw clamp shown resting in a horizontal position along the upper shelf. The small shelf above this holds three Barnes dropping bottles containing dilute starch paste, phenolphthalein (0.5 per cent alcoholic) and methyl orange (0.05 per cent aqueous), the indicators required. On the shelf to the right are bottles for three other solutions (manganese sulphate, 480 grams, hydrous, with four molecules

[1]The concentrations of the solutions indicated are taken from American Public Health Association, 1936, Standard Methods of Water Analysis, Eighth Edition, New York.

Fig. 1. Inside of the body of the case showing position of bottles and other equipment as described in the text.

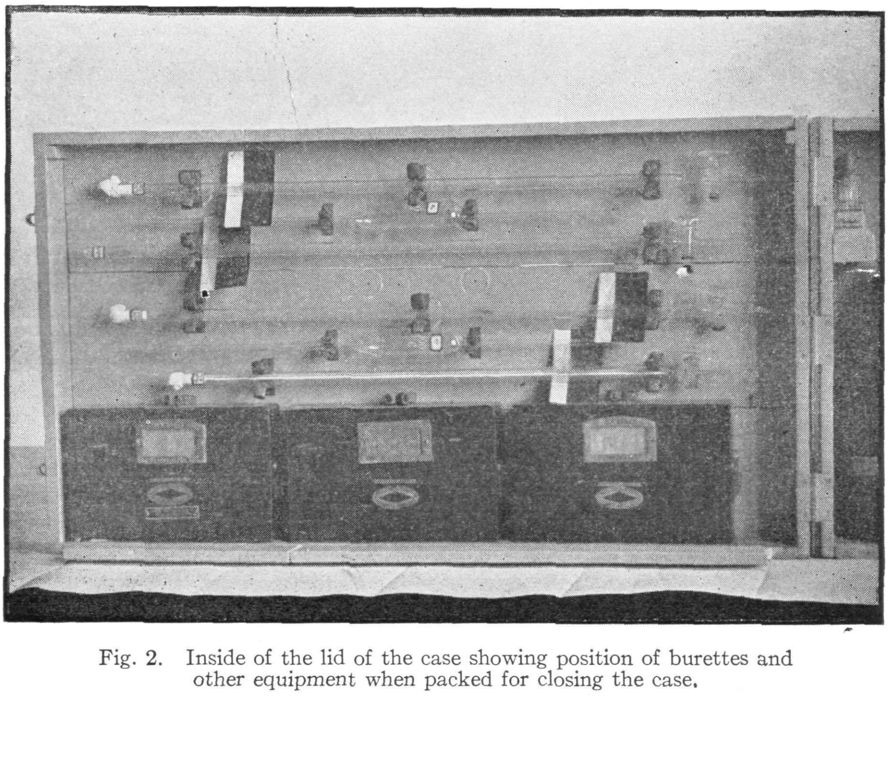

Fig. 2. Inside of the lid of the case showing position of burettes and other equipment when packed for closing the case.

of water per liter; sodium hydroxide, 500 grams, and potassium iodide, 150 grams per liter; concentrated sulphuric acid) required by the Winkler method (manganese chloride and hydrochloric acid are optional). Next, are six bottles of approximately 130 millimeters capacity labelled in pairs for duplicate water samples for oxygen determination.

Below are liter bottles of $N/50$ sulphuric acid and $N/44$ sodium hydroxide, for titration of carbonates and free carbon dioxide, and distilled water for rinsing pipettes and burettes. Next are four 250-milliliter bottles labelled in pairs for collecting water samples used in this analysis. All bottles are held in place with an ordinary web book strap laced through one inch staples properly spaced between the bottles. The labels are waterproofed with "Plicote" label glaze. In front of the lower tier of bottles are three wooden tubes holding one millimeter volumetric pipettes used for adding solutions in the Winkler method. Each tube and pipette is labelled according to the solution used to prevent contamination and mixing. Several stirring rods, towels, etc., may be carried here also. Inserted in holes bored diagonally through the shelf are three three-inch funnels suitable for pouring solutions into burettes and labelled according to the solution and burette with which each is used. Resting on the shelf below the funnels are three four-inch porcelain casseroles needed for titration of the water samples.

Inside the lid (Figure 2) are found four 50 milliliter, glass-stopcock burettes, one with a sidearm delivery tube, and two 100-milliliter volumetric pipettes which are held in place by metal finger-tip clamps covered with rubber tubing. Below is space for three La Motte block comparators of the standard six-cylinder style for colorimetric pH determination. The indicators carried can be varied according to local needs but thymol blue (9.6–8.0), phenol red (8.4–6.8) and chlor-phenol red (6.8–5.2) or brom-cresol purple (6.8–5.2) serve most requirements.

USE OF THE EQUIPMENT

When the case is to be made ready for use the block comparators are removed and the hinged strip in front of them is lowered, as shown in Figure 2, to form a shelf for the casseroles. After the burettes have been removed from the clamps the latter may be turned ninety degrees and are so placed that the burettes may be inserted in them in a vertical position. The top of the lid is hinged so that it may be lifted to permit the burettes to project above the top of the case when in position for use.

The sidearm burette, used for sodium thiosulphate, is placed in the clamps nearest the hinged end allowing the delivery tube of the solution bottle, placed on top of the box, to connect conveniently. A small calcium chloride tube is provided for the top of this burette. Two burettes are marked for use with sulphuric acid and sodium hydroxide respectively. The fourth burette is provided for titration with $N/50$ sulphuric acid to determine total acidity, when that is desired, or for titration with silver nitrate (2.725 per cent with 8 per cent potassium chromate as an indicator, Harvey, 1928) for determination of salinity in marine habitats. In that case the additional solution bottles may be placed to suit individual convenience or expediency. For example, if a wider shelf is used the funnels may be moved to the left and all the sample bottles placed in a double row to the right. Then five liter bottles may be placed in the bottom row and the casseroles stacked in the right hand end.

Two 100-millimeter pipettes are provided for measuring samples of water to be titrated so that two people may work simultaneously as is generally the case. Surface or sub-surface samples may be collected readily without bubbling with a rubber tube fitted with a double-acting aspirator bulb. This tube, not shown in Figure 1, is usually carried in the space above the two-liter bottle. The 250-milliliter sample bottles are used for the Seyler method because that size permits the titration of 100 milliliters of water with acid and another 100 milliliters from the same bottle with alkali, or the separate titration of 100 milliliters with phenolphthalein and with methyl orange indicators if that is desired when no alkali titration is required.

The preparation and use of solutions, the collection and analysis of suitable water samples and the interpretation of the methods referred to in this description are extensively discussed by Allee and Oesting (1934), American Public Health Association (1936), Birge and Juday (1911), Ellms and Beneker (1901), Harvey (1928) and Seyler (1894). The use of the concentrations indicated and samples of appropriate volume reduces the calculation of results to such simple arithmetic that it can be carried out immediately in the field. For the convenience of students who may use these directions without having available the references mentioned the following calculations are indicated. The first four are taken from American Public Health Association, 1936; the last one and the corrections for salt error in pH are from Harvey, 1928.

For oxygen in parts per million (100 ml. sample).

$$2 \times \text{ml. of } N/40 \text{ sodium thiosulphate} \times F^n \times F^v$$

F^n is a normality factor; F^v is a correction for the loss of 2 ml. of water when solutions are added to the sample bottle. Using a 130 ml. bottle, $F^v = 130 \div (130—2) = 1.016$.

For carbon dioxide in p. p. m. (100 ml. sample).

$$10 \times \text{ml. of } N/44 \text{ sodium hydroxide.}$$

Free carbon dioxide × 2.272 equals free carbon dioxide in terms of p. p. m. of calcium carbonate.

For phenolphthalein alkalinity in terms of p. p. m. of calcium carbonate (100 ml. sample).

$$10 \times \text{ml. of } N/50 \text{ sulphuric acid.}$$

For methyl orange alkalinity in terms of p. p. m. of calcium carbonate (100 ml. sample).

$$10 \times \text{ml. of } N/50 \text{ sulphuric acid.}$$

For salinity in parts per thousand (10 ml. sample).

Salinity in p. p. t. = ml. of 2.725 per cent silver nitrate.

Corrections for salt error in pH of sea water.

Indicator	Salt Solution	pH Correction
0.04 per cent thymol blue (8.0–9.6)	.5N NaCl	—0.17
0.02 per cent phenol red (6.8–8.4)	" "	—0.15
0.04 per cent brom-cresol purple (5.2–6.8)	" "	—0.25

The advantages of using a portable case of this kind vary, of course, with the circumstances. In the case of class work the main advantage has been the assignment of the factor analysis on a particular field trip to several students who carry out that phase of the work during the first hour in the field while others collect. Later, all join the leader in locating animals that have been missed previously and in observing the numbers, activities and adaptations of organisms collected. Rotation of this assignment permits all to practice the methods without unnecessary repetition. Another obvious advantage is the availability of additional samples when one is spoiled by the carelessness or clumsiness of beginners, making it possible to have complete data in the reports of every trip. Finally, upon returning to the laboratory, the factor analysis being complete, all can take part in storing alive, preserving and examining all the specimens collected. This is especially important after an afternoon trip when time is limited.

To advanced students and working ecologists engaged in seasonal or other extended studies of the physical conditions of various habitats the advantages are those of convenience in transportation as well as speed, accuracy and completeness in obtaining results. In one instance, when a small panel truck was used for carrying camping, collecting and other field equipment, this case served as a convenient field laboratory keeping the glassware safe from jarring while in transit on rough roads and ready for use as soon as the rear of the truck was opened. Although experience with the case as described has been very satisfactory, no doubt suggestions for improvement can be made and will be welcome from any who care to submit them.

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